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Promising ICT Transfer Fields for Promotion of Micro-Startups

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Abstract

Technology transfer in public sector has been generally performed with large firms and high-tech ventures due to high level of expertise knowledge and capability demands with the objects of realizing successful commercialization. But recent public and private promotions of startups with ICT niche services, public institutions began to have interests on possibilities of technology transfer with these none technology based startups. Thereof, the purpose of this study is to to review the most suitable technology transfer assessment measurements particularly focusing on non-technology based pre-startups and micro-startups. Based on the reviewed and selected measurements, 323 technologies of the Electronics and Telecommunications Research Institute (ETRI) were evaluated. This study conducted expert interviews and face-to-face expert surveys to draw 60 promising public technologies that can be the most suitable to ICT start-ups. The evaluation results indicated that 'Environment Control System for Smart Greenhouse', 'Fixed-PTZ Camera-linked Face Tracking Technology' and 'Multi-layer Copper-clad Fabric Circuit Board (FCB) Technology' were the top three, respectively. The findings of this study would be a guideline for the promotion of ICT-based startup businesses. The approach and findings of this study contributes to the initial stage of the theoretical and empirical research idea of the non-technology based ICT startups.

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Keywords: Technology Transfer; Public Research Institute; ICT Service Start-ups; Non-Technology based Start-ups; Promising Start-ups Technology Capabilities; Tehnology & Feasibility Assessment

1. Introduction

According to the digital economy outlook announced by the OECD in 2015, the Republic of Korea ranked highest in terms of the percentage of added values to GDP in the ICT industry as of 2013 [1]. In fact, based on a high level of ICT infrastructure, the Republic of Korea has provided diverse services. In addition, industrial

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changes and market growth have rapidly occurred. The success stories of startup businesses in ICT such as Olaworks and NEXR have been written and people's interest in ICT-based micro- startup has been on the rise.

In major foreign countries as well, there has been a great deal of support for startup businesses in ICT, such as Facebook taking over the virtual reality headset developer 'Oculus Rift' and Google acquiring the smart home device marker 'Nest.'. The U.S. has fostered innovative businesses through 'Startup America' since 2011. They provide funds and diverse programs such as mentoring for growth to alleviate startup businesses' financial burdens in the beginning stages of the businesses. Furthermore, there has been convergence between the government and private sectors such as a private startup incubation program. The U.K. has concentrated on businesses with growth potential by supporting technology-based startup businesses [2]. Israel has selected and supported approximately 100 businesses every year by analyzing their technology and marketability [3].

Korean government has expanded assistance and investment in startup candidates and startup businesses in ICT for job creation and economic growth through the promotion of startup businesses. However, government support is poor in terms of linkage for startup with R&D programs. Furthermore, it often ends as a one-time event so the general public has found it difficult to continue their businesses [4]. Although government-funded technology development and management have been kept to a certain level, the commercialization of technical asset as well as, the outcome of technology development, has been poor [5]. In case of technology-based startup businesses, high costs and risks exist in the initial stages. Therefore, startup businesses face difficulty in attracting investments needed for technology advancement in the beginning. In particular, the startup ecosystem in the Republic of Korea is not in a circle of 'startup → growth → recovery → reinvestment'. As a result small businesses find it challenging to launch businesses [6]. Therefore, in order to secure global competitiveness, government-led startup incubation policies and advanced technology-based startup promotion and support policies should be promoted.

Previous studies have concentrated on institutional aspects for the promotion of technology transfer, limiting the technology startup and transfer targets to experts and big businesses only. In other words, few studies have been conducted on business startups from the perspective of the general public and micro-startups. Therefore, this study attempts to select and suggest promising technologies for business startup by the general public and micro-startup businesses, focusing on technicity and feasibility.

This paper is structured as follows. Chapter 2, includes literature studies on influential factors, focusing on technicity and feasibility for the purpose of deriving promising technology assessment indicators which are good for small startup businesses. Based on the results, assessment indicators needed to select promising technologies are then suggested. In Chapter 3, the research method is explained. In Chapter 4, research results are stated. In Chapter 5, conclusions and implications are discussed.

2. Literature Studies and Assessment Index Model

2.1. Studies on assessment index requirements for technical analysis

In domestic technology assessment markets, technology assessment is applied with particular purposes, focusing on government-led suppliers only. Due to a lack of standardized technical assessment models, evaluation agencies have different evaluation criteria. Furthermore, the evaluation board lacks technical knowledge and tends to make a decision based on subjective criteria. Unlike advanced countries which have professional assessment tool development & technical assessment agencies, the Republic of Korea does not. If standardized technical assessment models are introduced and operated, it can be expected that the assessment

results will be fair and reliable.

In the domestic startup market, startup-related objective indicators have been improved by the effort of government and private sectors' making infrastructure for startups. However, negative views on business startup still prevail, and the percentage of restaurant business-related startup is high. In other words, the promotion of opportunity-driven startups has been relatively poor. Although both public and private sectors have internally evaluated technology for business startups and made some suggestions, they have been less reliable for startup candidates and the general public. Therefore, technical startups have become less popular. Hence, this study attempted to derive technical assessments for quantitative and qualitative assessments.

2.1.1. Influential factors for technical analysis

According the scope and type of technical assessment proposed by the Korea Technology Finance Corporation (KIBO), it is divided into technicity, technical value, and technical feasibility.

Cho Gyeong-seon and Im Jae-yong insisted that technical assessment can be divided into technical influence, technical capability, technical performance, technical achievements and technical values depending on the diverse attributes of technical phenomena [7]. According to the technical assessment by the NTTC in the U.S., the following ten indicators are evaluated based on qualitative assessment: technical advantages, monopolistic position, competitive environment, market attractiveness, technical handicap, manufacturing capability, regulation, time of release, organizational conditions, and disinvestment [8].

This study configured technical assessment elements for startup for micro businesses from a startup perspective as well as technical feasibility assessment based on domestic and overseas technical assessment methods as shown in Figure 1 below. The attributes of promising startup technologies were obtained based on the scope of technical assessment in the KIBO. Then collecting and reclassifying the assessment items from previous studies, the remaining items were classified.

2.1.2. Technical assessment indicators for selection of promising startup technology

In this study, assessment items were divided as stated in Table 1 by focusing on the selection of the technologies suitable for the startup of micro businesses for the general public. The assessment items are divided into reliability, superiority, applicability, innovation, and feasibility of the technology. The sub-assessment items include life cycle, durability and safety, uniqueness, performance differentiation, difficulty of technology transfer, technical applicability / extensibility, technology dependence, level of technology and infrastructure and risk factors.

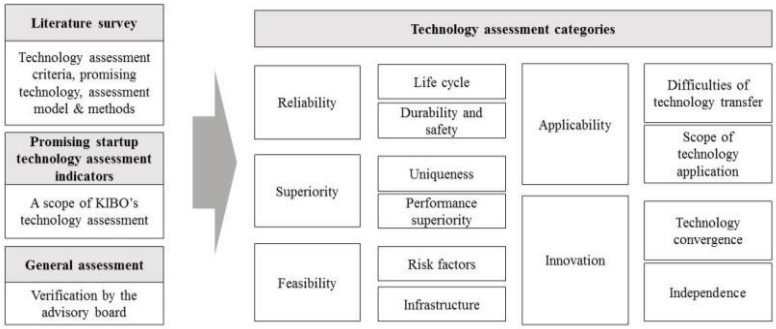

Figure 1. Technical Assessment Indicators

Table 1. Technical Assessment

Category	Matters Considered at Assessment (Purposes)	Sub-category
Reliability (20%)	- The life cycle of the technology before technology transfer - Durability, safety and other matters at technology transfer	- Life cycle - Durability and safety
Superiority (25%)	- Uniqueness of the technology - Difference between the technology and similar technologies in terms of performance	- Uniqueness - Performance differentiation
Applicability (20%)	- Entry barrier and technology difficulty for technology transfer - Technology linkage with other fields after technology transfer and scope of technology applications	- Difficulties of technology transfer - Possibility of technology application and extension
Innovation (15%)	- A possibility of technology convergence with other fields - Independence of the technology	- Possibility of technology convergence - Technology independence
Feasibility (20%)	- Technology conditions such as a level of domestic technology and infrastructure - Risk factors of the technology	- Level of technology and infrastructure - Risk factors

2.2. Studies on assessment index requirements for feasibility analysis

Many OECD member states use the Oslo Manual for the assessment of innovative technology feasibility. Because of empirical surveys on domestic technology and service providers' management innovation activities, the assessment system has been deemed reliable. However, it has a limitation as a market performance tool on the innovation technology itself. In addition, there have been few tools or standardized methodologies which can evaluate promising startup technologies for the general public. Therefore, this study attempted to develop hybrid assessment indicators by introducing influential factors which can predict the feasibility of innovative technologies based on the Oslo Manual.

Since innovative technology has high uncertainty on market for development costs. Researchers have discussed the distribution of innovative technology to market in diverse aspects and verified the factors affecting performances such as technology adoption, technology diffusion, and technology transfer [9][10][11][12]. This study aimed to investigate the feasibility of promising startup innovation technologies from the perspectives of technology transfer and technology diffusion.

Technology transfer is defined as "the development of a technology in one setting which is then transferred for used in another setting," focusing on the producer of the technology. [13] In contrast, technology diffusion refers to the spread of technology by the society, organizations or individuals. [12] This process mostly concentrates on end users [10].

2.2.1. Factors affecting technology commercialization observed from the perspective of technology transfer

Johnson et al. mentioned social, policy, economic, personal and cultural elements in terms of barriers during technology transfer [10]. Regarding the issues affecting technology transfer, the importance was discussed with 'appropriateness of technologies' and 'change agent.' Greiner and Franza also divided technology transfer into

barriers as well as success factors and suggested the factors relating to the organization's internal competence such as personnel, operators and internal & external communication abilities [14][10].

Kang et al. suggested 'appropriability regime, innovation competency, open innovation activities, techno-uncertainty and government support' as the factors affecting the technology feasibility of government-funded businesses. Depending on the size of the business, the preference of a government support program differs. However, a financial aid needed for R&D and commercialization was deemed important [15]. Sohn et al. classified the assessment factors needed to predict the success of technology feasibility into "technology provider's research competency, technology adopters, environmental factors, and transfer" and stated that the success of technology feasibility was low. They also suggested that they caused the consumption of many resources [16].

2.2.2. Factors affecting technology commercialization observed from the perspective of spread of technology

The studies covering the matters considered in terms of marketability and feasibility from the perspective of technology diffusion are as follows: Rogers insisted that adopters' acceptance speed differs depending on the relative advantage, compatibility, complexity, triability, and observability of innovation [12]. Hall and Khan suggested determinants affecting technology diffusion focusing on "demand determinants – technical level of personnel & capital, network effects, customer trust & relationship," "supply behavior – performance improvement in new technology, performance improvement in former technology, complementary input" and "environmental & institutional factors – market structure and business size, government & regulations." [17]

In his study, Lee Yeong-chan analyzed technical assessment indicators needed to select R&D technology venture investments for small venture businesses and performance of technology feasibility. As a result, it was confirmed that technology feasibility such as completeness, market share, and awareness is important [18]. Therefore for the evaluation of innovative technology or R&D project support feasibility, the assessment items can be divided into three categories: business management and project promotion ability, marketability and feasibility.

According to a study by the Korea Institute of Science and Technology Information (KISTI), both qualitative and quantitative analysis methods were chosen by mixing BOE and KISTI-SERI models as a methodology to discover promising items in technology market [19]. The quantitative methodology is configured as follows. First, to select the primary analysis target group, patent trends were analyzed based on the IPC codes in which the frequency of patent application for the past decade has skyrocketed. At the second analysis, mega trends were examined by performing Industry of Manufacture (IOM) and Sector of Use (SOU). At the third analysis, promising item candidate groups were derived through keyword analysis and co-occurrence analysis on the items which newly appeared from the previous year. Lastly, promising items were chosen using qualitative methodology and final conclusion was derived from developing an assessment model based on major assessment indicators (e.g., market size, technology innovation, etc.).

2.2.3. Feasibility assessment indicators for the selection of promising startup technology

Based on the determinants suggested above, marketability and feasibility are derived from the perspective of technology transfer and technology diffusion, and the indexes were developed as stated in Table 2. At the stage of technology transfer, the selection of qualified technologies needed for micro-startup candidates to commercialize the technologies provided by the government-funded research institutes was focused. The level of business startup candidates' technology development competency and the matters needed to select the technology for the creation of short-term results with easy market entry after prototype development were considered. In technology diffusion stage, it is targeted to evaluate the technologies with convenience for penetrating into the latent market through the commercialization of the technology and appropriate level of demand. For successful technology feasibility, external environment should also be considered. Therefore, the assessment items were divided into market size, market entry, and demand and supply ability.

Based on these backgrounds, this study considered the persistence of the market or industry in which the target technologies from the perspective of micro-startups, predicted market demand and difficulty of market entry.

Table 2. Feasibility and Marketability Assessment Indicators

Classification	Category	Matters Considered at Assessment (Purposes)	Sub-category
[Technology transfer] Feasibility assessment items	Technology feasibility support environment (35%)	- Prototype development; product commercialization; government-funded project and funding possibility to get the resources needed for technology feasibility	- Level of government-funded businesses - Difficulty of attracting investments
	Technology Feasibility (35%)	- Possibility for startup business candidates to create profits within 3 years based on the additional development size and market profitability of the target technology	- Possibility to create profit at startup - Difficulty of developing prototype
	Potential of Feasibility Items (30%)	- Assessment on the possibility to create the 3rd products and services based on the target technology and ripple effects of the related market	- Diversity of creating derivative services and products
[Technology diffusion] Marketability assessment items	Market size (30%)	- Review on market size and growth potential based on domestic and overseas market analysis reports and reports of the Bank of Korea	- Market growth forecast
	Possibility of market entry (30%)	- Assessment on the easiness of market penetration into the market where the target technology is present from the perspective of small business	- Difficulty for small businesses to penetrate into the market
	Market Demand (30%)	- Review on demand possibility, supplier's capability required at the product diffusion stage and difficulty of product production	- Diversity in the range of potential clients
	Market supply ability (10%)	- Market supply ability required for small startup businesses	- Required market supply ability

3. Research Method

In terms of a research scope, a total of 323 technologies announced by the ETRI from 2012 to 2014 were targeted. Among them, 60 technologies suitable for micro-startups were chosen after going through the three step evaluation processes.

In Step 1 (redundancy assessment), 268 technologies were derived from 323 by excluding redundant technology. In Step 2 (technical assessment), the technologies which were technically stable and ranked level 6 or higher in terms of technology readiness level (TRL) were chosen. The technical values (e.g., technical stability, technical superiority, etc.) and insufficient capital were considered. After excluding the technologies which were too large for small businesses, classified them by the scope of technology transfer, technical utilization, and technical development and a total of 104 technologies were selected based on small technology. In Step 3 (feasibility assessment), technologies were classified based on the industry to which the previous technologies are applicable and diversity of creating derivative services. In consideration of the dominance or extinction of conventional services in product and service market and market entry barriers, the technologies which are relatively high in terms of diversity and possibility of creating short-term profits were classified first. Then, the final 60 technologies were chosen.

Next, an expert questionnaire survey was conducted against the 60 technologies. They were ranked through assessment and analysis. For technical assessment, ten college professors were invited. In addition, 4 college processors, three research lab engineers and three experts from private firms participated in the feasibility assessment.

In terms of analysis of the survey results for technical assessment, the mean of 5-point Likert scale in each item was obtained based on the ratio of the weighted values in assessment items in Table 1. Then, the mean of two assessment categories (feasibility and marketability) was expressed with the scores of total feasibility converted by 50% each.

Total technical scores (100) = (reliability mean/5 * 20% of weighted value of assessment items) + (mean of superiority/5 * 25% of weighted value of assessment items) + (applicability mean/5 * 20% of weighted value of assessment items) + (innovation mean/5 * 15% of weighted value of assessment items) + 50% of (feasibility mean/5 * 20% of weighted value of assessment items)

The analysis of the expert questionnaire survey data for feasibility assessment is performed as follows: The mean of a 5-point Likert scale in each category was converted into percentage based on the ratio of weighted value in the assessment items in Table 2. Then, the mean of two assessment categories (feasibility and marketability) was expressed with the scores of total feasibility converted by 50% each.

Total feasibility scores (100) = [technology transfer] feasibility item total + [technology diffusion] market total

[Technology transfer] feasibility item total = (mean of difficulty of attracting investments/5 * 35% of weighted value of assessment items) + (mean of the possibility of creating profits/5 * 35% of weighted value of assessment items) + 50% of (mean of diversity of creating derivatives/5 * 35% of weighted value of assessment items)

[Technology diffusion] market item total = (mean of market growth potential/5 * 30%) + (mean of difficulty of market entry/5 * 30%) + (mean of diversity in the range of potential users/5 * 33 %) + 50% of (mean of market supply ability/5 * 10%)

4. Results

Among 60 promising startup technologies, this paper suggests top 20. The analysis results are summarized in Table 2 below. This table reveals the technologies in order, which have been ranked in terms of feasibility and technicity.

Table 3. Top 20 Promising Startup Technologies

Category	Title	Technicity	Feasibility	Total	Rank
Software contents	Environment Control System for Smart Greenhouse	75.00%	68.90%	71.95%	1
Software contents	Fixed-PTZ Camera-linked Face Tracking Technology	69.60%	72.50%	71.05%	2
Software contents	Multi-layer Copper-clad Fabric Circuit Board (FCB) Technology	70.80%	70.45%	70.63%	3
Software contents	Broadband 3D Modelling Technology Using Omni-directional Images and LiDAR Data	71.40%	69.06%	70.23%	4
Software contents	Voice Recognition-based Interactive English Language Learning Technology (Genie Tutor)	72.20%	67.40%	69.80%	5
Software contents	Digital Graffiti Canvas	70.20%	69.35%	69.78%	6
Parts & Material	Resonant Multiple Wireless Energy Transmission Technology	71.80%	67.50%	69.65%	7
Software contents	Knowledge Learning-based Korean-Chinese (or Chinese-Korean) Interactive Automatic Translation Technology	75.20%	64.05%	69.63%	8
Convergence technology	In-ear Module & Monitoring System for Diagnosis of Livestock Disease	70.20%	67.55%	68.88%	9
Software contents	Projection Computer-based Augmented Reality (AR) Services and Bare-handed User Interface Technology	70.20%	67.25%	68.73%	10
Software contents	Smart Device Mode-based Human Social Relationships	71.20%	65.40%	68.30%	11
Broadcast communication	Unstructured Data Context Extraction & Semantic Tagging Technology	64.40%	71.35%	67.88%	12
Software contents	MTM-based Smart Device Security Technology	70.60%	63.50%	67.05%	13
Software contents	Automatic Interpretation-purposed Dialogic Japanese Language Recognition Technology	62.80%	70.95%	66.88%	14
Software contents	Pre-Association Message (PAM) for a Mobile Device-based Local Push Technology	63.80%	69.10%	66.45%	15
Software contents	Abnormal & Safety-threatening Behaviour Pattern Recognition Technology in CCTV Environment	71.20%	61.35%	66.28%	16
Software contents	SNS Forensic Data Visualization Technology	70.80%	61.70%	66.25%	17
Communication & Internet	Design of Transparent Film for Electromagnetic Wave Suppression	62.00%	70.50%	66.25%	18
Communication & Internet	Non-IP Sensor-functioned IETF CoAP-based Sensor Connection Protocol Technology	65.40%	66.05%	65.73%	19
Convergence technology	5m-precision Location-Based Service (LBS) Service Provisioning Platform Technology	70.20%	60.90%	65.55%	20

5. Conclusion and Implications

Recently, there has been rising interest in innovative technology-based business startups and general business startup around the globe. In the past, technology-based business was mostly launched by experts and big businesses only. However, with the development of ICT, small businesses are now able to try this business

as well. As a way to encourage the general public to launch these kinds of technology-based businesses, the government-led technology transfer has been mentioned. Therefore, this study attempted to analyze and suggest promising technologies for micro-startups through technology transfer. In general for assessment on promising startup technologies, reliable and professional agencies are needed. In advanced countries, the assessment results are highly reliable because they have technical assessment agencies. In contrast, in the Republic of Korea, technical assessment is led by the government. However, the Korean government's assessment on promising technologies is less reliable due to a lack of professional personnel and expertise.

Currently, Korea's startup market is mostly led by the restaurant business for the purpose of making a living. However, considering industrial ripple effects and competitiveness, technology innovation-centered startups are more desirable for the growth of national economy. Recently, there has been an attempt to expand technology innovation-oriented business startups through government-led technology transfer. Under these circumstances, there should be the selection and support for systematic technology innovation and technology transfer. In other words, policies must be developed to promote the related activities such as discovery and support for new industry, performance management and linkage with ICT industries. Therefore, this study analyzed and suggested promising technologies suitable for the promotion of technology transfer for micro-startup.

In this regard, this study has gone through the following research procedures: First, a list of 268 technologies was compiled after reviewing technical redundancy on a total of 323 technologies proposed by the ETRI. Second, the 268 technologies were analyzed based on feasibility assessment indicators, while considering the technical assessment elements, market outlook, and ripple effects, focusing on technical features and competitiveness. As a result, 60 promising startup technologies were finally obtained and classified into the followings categories: software contents (18), convergence technology (10), broadcast communication (11), communication & Internet (13) and parts & material (8). After performing technical and feasibility assessments through 20 experts, the promising technologies for micro-startup were ranked. The top five technologies are i) Environment Control System for Smart Greenhouse, ii) Fixed-PTZ Camera-linked Face Tracking Technology, iii) Multi-layer Copper-clad Fabric Circuit Board (FCB) Technology, iv) Broadband 3D Modelling Technology Using Omni-directional Images and LiDAR Data, and v) Voice Recognition-based Interactive English Language Learning Technology (Genie Tutor). The study results have the following implications:

First, among the 20 promising technologies, those in software contents mostly ranked higher because it is believed that the contents-based service sector is relatively easy for startup candidates or small businesses that do not have sufficient capital and technology to launch business.

Second, the top ten promising technologies are closely related with ICT services recently spotlighted. For example, the top-ranked technology ('Environment Control System for Smart Greenhouse') uses the Internet of Things (IoT) which is one of Gartner's Top 10 Strategic Technologies announced for the past four years [20]. In addition, most high-ranked promising technologies such as artificial intelligence, wearable device, 3D and speech recognition are innovative technologies which have emerged in ICT industries. Therefore, if micro-startups keep moving forward with the above technology, they would have great growth potential and opportunity to succeed in this business.

Third, in the past, technology transfer was mostly performed by big businesses and experts, and the related studies were very limited. However, this study is meaningful in that it analyzed technology from the perspective of the general public, startup candidates, micro-startup businesses and venture businesses according to an increase in needs for business startups. It appears that these results would be helpful in promoting ICT-based startup businesses in the future.

Despite the said implications, this study has limitations in that it analyzed qualitative data through an expert questionnaire survey in evaluating the feasibility and technicity. Furthermore, the derived promising technologies in different fields (e.g., software contents, convergence technology, broadcast communication, communication & Internet, parts & material, etc.) can have a different direction in promoting commercialization. Therefore, there should be expanded questionnaire surveys and technical assessments through experts in diverse fields. In addition, it is needed to perform technology transfer through in-depth analysis in each category.

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